

W. M. Dunkle

50-I

# DENSITY OF SEA WATER

AT

COAST AND GEODETIC SURVEY TIDE STATIONS

PACIFIC OCEAN

DW-2

REVISED 1946

DEPARTMENT OF COMMERCE

U. S. COAST AND GEODETIC SURVEY

WASHINGTON

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1946

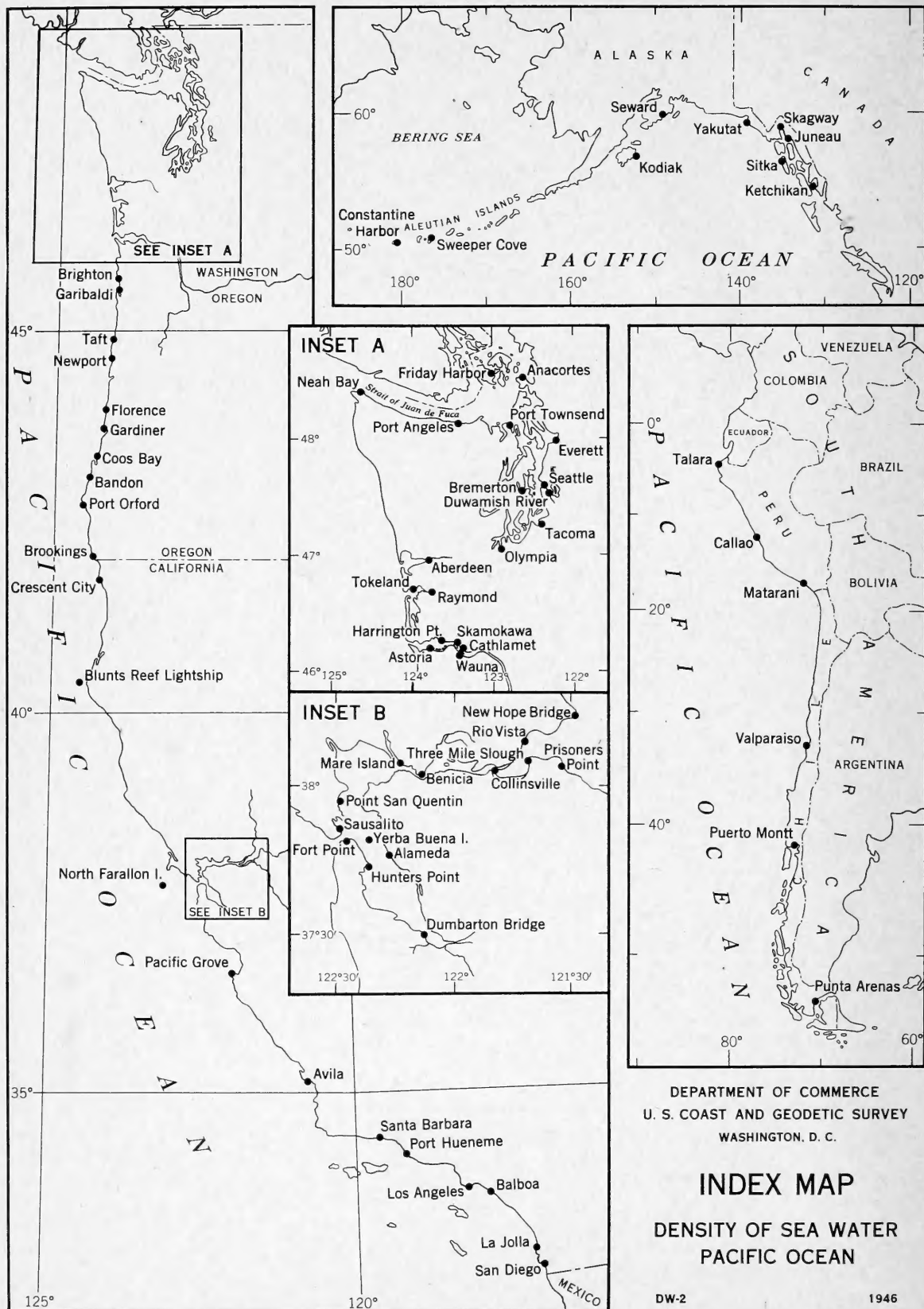
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## LIST OF STATIONS

Station	Lat.	Long.	Page
CALIFORNIA	North	West	
San Diego -----	32 43	117 10	6
La Jolla -----	32 52	117 15	6
Balboa -----	33 36	117 54	27
Los Angeles Harbor -----	33 43	118 16	7
Port Hueneme -----	34 09	119 12	27
Santa Barbara -----	34 25	119 41	8
Avila -----	35 10	120 44	8
Pacific Grove -----	36 38	121 55	27
North Farallon Island -----	37 46	123 06	27
<i>San Francisco Bay and Tributaries</i>			
San Francisco (Fort Point) -----	37 48	122 27	8
San Francisco (Hunters Point) -----	37 44	122 22	9
Dumbarton Bridge -----	37 30	122 07	9
Alameda (Naval Air Station) -----	37 46	122 18	9
Yerba Buena Island -----	37 49	122 22	10
Sausalito -----	37 51	122 29	10
Point San Quentin -----	37 57	122 29	10
Mare Island (Navy Yard) -----	38 06	122 16	10
Benicia, Carquinez Strait -----	38 03	122 08	10
Three Mile Slough, San Joaquin River ---	38 05	121 41	10
Prisoners Point, San Joaquin River -----	38 04	121 33	11
Collinsville, Sacramento River -----	38 04	121 51	11
Rio Vista, Sacramento River -----	38 09	121 42	11
New Hope Bridge, Mokelumne River -----	38 14	121 29	11
Blunts Reef Lightship -----	40 26	124 30	27
Crescent City -----	41 45	124 12	12
<b>OREGON</b>			
Brookings -----	42 03	124 17	12
Port Orford -----	42 44	124 30	12
Bandon, Coquille River -----	43 07	124 25	13
Coos Bay entrance -----	43 21	124 19	13
Gardiner, Umpqua River -----	43 44	124 07	13
Florence, Siuslaw River -----	43 58	124 06	13
Newport, Yaquina Bay -----	44 38	124 03	13
Taft, Siletz Bay -----	44 56	124 01	13
Garibaldi, Tillamook Bay -----	45 33	123 55	13
Brighton, Nehalem River -----	45 40	123 56	14
<i>Columbia River</i>			
Astoria (Tongue Point) -----	46 13	123 46	14
Wauna -----	46 10	123 24	15

LIST OF STATIONS — *Continued*

Station	Lat. ° ' "	Long. ° ' "	Page
<b>WASHINGTON</b>			
<i>Columbia River</i>			
Harrington Point -----	46 16	123 39	15
Skamokawa -----	46 16	123 27	15
Cathlamet -----	46 12	123 23	15
Tokeland, Willapa Bay -----	46 42	123 58	16
Raymond, Willapa River -----	46 41	123 45	16
Aberdeen, Grays Harbor -----	46 58	123 51	17
<i>Puget Sound and Approaches</i>			
Neah Bay -----	48 22	124 37	17
Port Angeles -----	48 07	123 26	17
Port Townsend (Fort Worden) -----	48 08	122 46	17
Everett -----	47 59	122 13	18
Bremerton -----	47 33	122 38	18
Seattle (Elliott Bay) -----	47 36	122 20	18
Seattle (Duwamish River) -----	47 32	122 19	19
Tacoma -----	47 17	122 25	19
Olympia -----	47 03	122 54	19
Anacortes -----	48 31	122 37	20
Friday Harbor, San Juan Island -----	48 33	123 00	20
<b>ALASKA</b>			
Ketchikan -----	55 21	131 39	21
Sitka -----	57 03	135 20	22
Juneau -----	58 18	134 25	22
Skagway -----	59 27	135 19	23
Yakutat -----	59 33	139 44	24
Seward -----	60 06	149 27	23
Kodiak -----	57 47	152 24	24
Sweeper Cove, Adak Island -----	51 51	176 39	24
Constantine Harbor, Amchitka Island -----	51 25	180 42	24
<b>HAWAIIAN ISLANDS</b>			
Honolulu -----	21 18	157 52	25
Sand Island, Midway Islands -----	28 12	177 22	25
<b>SOUTH AMERICA</b>			
	<i>South</i>	<i>West</i>	
Punta Arenas, Magellan Strait, Chile -----	53 09	70 54	25
Puerto Montt, Chile -----	41 29	72 58	25
Valparaiso, Chile -----	33 02	71 38	25
Matarani, Peru -----	17 00	72 07	26
Callao, Peru -----	12 03	77 09	26
Talara, Peru -----	4 35	81 17	26



## INTRODUCTION

The monthly mean and yearly mean and extreme densities of sea water given on the following pages are based on hydrometer readings which usually were made once each day from water samples drawn from near the surface. These observations were made at tide stations maintained by the U. S. Coast and Geodetic Survey along the Pacific Coast of the United States, Alaska, and the Hawaiian Islands, and at stations maintained cooperatively in Chile and Peru. A supplemental table is included which shows average monthly surface salinities at places along the California coast as furnished by the Scripps Institution of Oceanography.

The **UNIT OF DENSITY** is the density of fresh water at a temperature of  $4^{\circ}\text{C}$  ( $39.2^{\circ}\text{F}$ ). The actual density of the water may vary from a little less than unity for fresh water at a temperature other than  $4^{\circ}\text{C}$  to approximately 1.0310 for the heaviest sea water. Since the density of sea water, as observed, depends not only upon the amount of soluble matter contained in a unit volume, but also upon the temperature of the water at the time the reading was made, it is necessary to reduce the observed densities to some standard temperature in order that they may be comparable and indicate the amount of matter held in solution. **IN THIS PUBLICATION THE OBSERVED DENSITIES HAVE BEEN REDUCED TO A STANDARD TEMPERATURE OF  $15^{\circ}\text{C}$  ( $59^{\circ}\text{F}$ ).** The density of pure water at a temperature of  $15^{\circ}\text{C}$  is taken as 0.9991.

The **SALINITY** of sea water is defined as the number of grams of salts contained in 1000 grams of sea water. While the total amount of salts contained in a given volume of sea water varies in different places, the relative portions of the different kinds of salt are nearly constant in all parts of the ocean. The salinity of sea water may be determined by several different methods, one of the simplest being based upon the density of the water as obtained from use of the hydrometer. The table on the inside back cover gives the salinity corresponding to different values of density at the standard temperature of  $15^{\circ}\text{C}$  to which all densities in this publication are referred.

In the following table the mean and extreme densities for each series are given on the line labeled "Mean density" whenever the series covers two years or more. On the next line the corresponding salinities are given. Other density values in the table can be converted to salinity, if desired, by means of the table in the back of the book. The seasonal variation in salinity is shown graphically for Coast and Geodetic Survey stations where the observations cover five years or more.

Other publications in this series, which are available from the U. S. Coast and Geodetic Survey, are as follows:

- TW-1. Surface Water Temperatures, Atlantic and Gulf Coasts.
- TW-2. Surface Water Temperatures, Pacific Coast.
- DW-1. Density of Sea Water, Atlantic and Gulf Coasts.

# Density of Sea Water

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Means	Extremes Max. Min.
SAN DIEGO, CALIF.														
1922	1.0240	1.0240	1.0241	1.0244	1.0247	1.0249	1.0251	1.0252	1.0251	1.0248	1.0248	1.0246	1.0246	1.0258 1.0228
1923	246	246	248	249	251	251	255	256	253	250	250	248	250	261 240
1924	248	249	249	249	251	251	253	251	252	250	250	247	250	261 237
1925	248	249	251	251	253	253	254	251	249	246	247	246	250	258 240
Mean Density	1.0246	1.0246	1.0247	1.0248	1.0250	1.0251	1.0253	1.0252	1.0251	1.0248	1.0249	1.0247	1.0249	1.0261 1.0228
Salinity	33.2	33.2	33.3	33.4	33.7	33.8	34.1	34.0	33.8	33.4	33.6	33.3	33.6	35.1 30.8
LA JOLLA, CALIF.														
1925	1.0250	1.0249	1.0249	1.0249	1.0250	1.0251	1.0251	1.0252	1.0248	1.0246	1.0248	1.0248	1.0249	1.0256 1.0240
1926	249	249	249	247	249	250	250	249	248	249	249	248	249	251 243
1927	248	243	245	248	248	249	249	250	250	249	249	248	248	250 224
1928	248	248	248	249	249	249	250	250	249	249	249	248	249	251 247
1929	249	249	249	249	250	250	251	250	249	249	250	250	250	252 248
1930	249	249	249	249	249	250	250	250	250	250	250	251	250	252 248
1931	251	250	251	251	250	251	252	251	250	250	250	250	251	252 249
1932	249	246	247	249	250	250	250	249	249	248	249	248	249	250 240
1933	248	248	248	249	250	251	250	250	250	250	250	249	249	251 245
1934	249	248	248	249	250	250	250	249	249	248	248	248	249	250 246
1935	248	247	248	248	249	249	249	249	248	248	248	249	248	250 241
1936	248	247	248	249	249	250	250	250	250	248	249	248	249	251 244
1937	248	246	245	247	249	250	250	250	250	250	250	249	249	251 237
1938	250	249	246	249	250	250	250	250	249	249	249	248	249	251 234
1939	248	248	249	249	250	251	251	251	249	250	250	250	250	252 243
1940	250	249	249	249	250	250	249	250	249	248	248	247	249	251 242





Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Means	Extremes Max. Min.
SANTA BARBARA, CALIF.														
1930	---	---	1.0251	1.0253	1.0253	1.0254	1.0254	1.0254	1.0252	1.0251	1.0252	1.0252	---	---
1931	1.0251	1.0253	253	254	253	254	255	255	253	253	252	249	1.0253	1.0260 1.0221
1932	250	247	251	252	254	255	---	---	---	---	---	---	---	---
Mean Density	1.0250	1.0250	1.0252	1.0253	1.0253	1.0254	1.0254	1.0254	1.0253	1.0252	1.0252	1.0251	1.0252	---
Salinity	33.7	33.7	34.0	34.1	34.1	34.2	34.2	34.2	34.1	34.0	34.0	33.8	34.0	---
AVILA, CALIF.														
1945	---	---	---	---	---	1.0257	1.0256	1.0258	1.0256	1.0253	1.0253	1.0251	---	---
SAN FRANCISCO (Fort Point), CALIF.														
1922	1.0218	1.0204	1.0180	1.0189	1.0173	1.0170	1.0207	1.0224	1.0231	1.0231	1.0227	1.0214	1.0206	1.0236 1.0124
1923	208	204	210	198	201	204	219	232	238	234	232	231	218	240 158
1924	231	225	223	229	232	238	245	247	249	249	241	230	237	251 210
1925	225	195	196	186	187	200	226	234	237	236	229	228	215	241 149
1926	228	196	200	183	203	223	232	243	242	242	239	213	220	246 132
1927	219	178	168	179	187	196	214	230	238	238	229	225	208	240 110
1928	220	208	206	180	211	222	233	240	241	239	235	228	222	244 125
1929	224	217	218	222	221	224	236	241	241	242	240	231	230	246 194
1930	215	217	191	201	213	227	237	242	241	242	240	234	225	245 164
1931	229	228	224	229	235	241	247	251	250	252	251	241	240	257 214
1932	209	199	210	210	202	203	216	232	237	237	238	235	219	243 148
1933	231	222	220	210	218	218	232	239	242	244	240	237	229	246 180
1934	213	222	212	217	227	235	241	246	251	246	240	229	232	256 178
1935	211	211	201	174	174	185	217	232	237	239	233	231	212	242 127

1936	211	197	170	187	187	200	224	235	238	236	234	232	213	241	114
1937	227	201	173	159	181	196	222	234	239	236	230	198	208	242	098
1938	200	150	131	147	157	167	203	224	230	231	228	224	191	243	050
1939	223	223	222	213	225	234	242	245	248	244	242	236	233	255	200
1940	203	182	134	137	188	209	226	237	242	240	231	223	204	246	043
1941	167	143	126	149	163	187	214	224	232	234	218	213	189	239	051
1942	190	138	189	174	187	174	223	229	---	---	---	---	---	238	094
1943	204	166	172	184	198	215	233	236	245	238	235	234	213	250	096
1944	231	222	214	228	219	223	235	244	246	243	234	228	231	252	169
1945	225	205	209	217	213	218	231	239	242	240	228	210	223	247	138
Mean Density	1.0215	1.0198	1.0192	1.0192	1.0200	1.0209	1.0227	1.0237	1.0241	1.0240	1.0234	1.0226	1.0218	1.0257	1.0043
Salinity	29.1	26.9	26.1	26.1	27.2	28.4	30.7	32.0	32.5	32.4	31.6	30.6	29.5	34.6	6.7
SAN FRANCISCO (Hunters Point), CALIF.															
1945	---	1.0156	1.0183	1.0186	1.0182	1.0198	1.0210	1.0222	1.0228	1.0224	1.0212	1.0185	---	1.0240	1.0119
DUMBARTON BRIDGE, SAN FRANCISCO BAY, CALIF.															
1937	1.0236	1.0195	1.0146	1.0114	1.0144	1.0164	1.0183	1.0204	1.0218	1.0222	---	---	---	---	---
ALAMEDA (Naval Air Station), CALIF.															
1939	---	---	1.0195	1.0191	1.0205	1.0220	1.0233	1.0244	1.0246	1.0242	1.0236	1.0230	---	---	---
1940	1.0174	1.0146	100	098	142	173	196	217	226	228	219	208	1.0177	1.0232	1.0012
1941	128	103	092	108	126	151	180	197	212	219	223	188	161	229	074
1942	148	093	128	133	140	152	176	200	214	216	210	198	167	220	071
1943	164	121	113	122	146	168	193	209	219	226	217	214	176	231	086
1944	206	181	170	184	187	196	210	222	232	232	212	202	203	238	116
1945	194	154	163	170	170	187	202	216	222	217	205	186	190	228	120
Mean Density	1.0169	1.0133	1.0137	1.0144	1.0159	1.0178	1.0199	1.0215	1.0224	1.0226	1.0217	1.0204	1.0184	1.0238	1.0012
Salinity	23.1	18.4	19.0	19.9	21.8	24.3	27.1	29.1	30.3	30.6	29.4	27.7	25.1	32.1	2.6











Density of Sea Water - *Continued*

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Means	Extremes Max. Min.
BRIGHTON, NEHALEM RIVER, ORE.														
1923	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1934	1.0041	1.0141	1.0106	1.0117	101	---	---	---	---	---	---	---	---	---
					1.0089	1.0099	1.0191	1.0202	1.0200	1.0171	1.0155	1.0043	---	---
													---	---
ASTORIA (Tongue Point), ORE.														
1925	0.9991	0.9991	0.9991	0.9993	0.9996	0.9997	0.9999	0.9995	0.9999	1.0008	1.0018	1.0007	0.9998	1.0072 0.9991
1926	1.0021	1.0005	1.0000	1.0005	0.9999	0.9999	0.9999	1.0005	1.0006	1.0008	1.0002	0.9996	1.0004	1.0062 0.9991
1927	1.0004	0.9997	0.9998	0.9998	0.9995	0.9997	0.9995	0.9993	0.9995	0.9996	0.9993	0.9991	0.9996	1.0044 0.9991
1928	0.9996	0.9996	0.9996	0.9994	0.9997	0.9996	0.9996	0.9993	0.9999	1.0001	1.0014	1.0022	0.9999	1.0072 0.9991
1929	1.0007	1.0017	0.9995	0.9995	0.9994	0.9996	0.9998	1.0002	1.0000	1.0016	1.0027	1.0016	1.0005	1.0088 0.9991
1930	1.0047	0.9992	1.0004	0.9998	0.9996	0.9997	0.9996	1.0001	1.0007	1.0018	1.0033	1.0042	1.0011	1.0095 0.9991
1931	1.0026	1.0020	1.0001	0.9998	0.9996	0.9995	0.9997	1.0005	1.0009	1.0021	1.0007	1.0022	1.0008	1.0102 0.9991
1932	0.9998	1.0008	0.9993	0.9993	0.9995	0.9998	0.9996	1.0000	1.0003	1.0011	0.9995	1.0003	0.9999	1.0062 0.9991
1933	0.9994	0.9996	0.9994	0.9993	0.9994	0.9995	0.9999	0.9995	0.9996	0.9999	0.9991	0.9991	0.9995	1.0035 0.9991
1934	0.9991	0.9994	0.9992	0.9991	0.9993	0.9993	0.9992	0.9995	1.0001	1.0012	1.0006	0.9997	0.9996	1.0067 0.9991
1935	1.0001	0.9999	0.9999	0.9999	0.9997	0.9999	0.9999	0.9998	1.0007	1.0020	1.0036	1.0051	1.0009	1.0095 0.9991
1936	0.9993	1.0025	0.9996	0.9998	0.9997	0.9997	0.9998	1.0005	1.0013	1.0037	1.0050	1.0037	1.0012	1.0097 0.9991
1937	1.0039	1.0008	1.0004	0.9997	0.9996	0.9993	0.9992	0.9999	1.0010	1.0028	1.0003	0.9996	1.0005	1.0095 0.9991
1938	0.9994	1.0004	0.9998	0.9995	0.9996	0.9997	0.9999	1.0000	1.0013	1.0021	1.0021	1.0009	1.0004	1.0059 0.9991
1939	1.0000	1.0000	0.9996	0.9991	0.9991	0.9991	0.9991	0.9995	1.0007	1.0021	1.0036	1.0011	1.0002	1.0080 0.9991
1940	1.0024	0.9998	0.9994	0.9991	0.9991	0.9992	0.9992	1.0001	1.0009	1.0023	1.0009	1.0021	1.0004	1.0096 0.9991



Density of Sea Water - *Continued*

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Means	Extremes Max. Min.
TOKELAND, WILLAPA BAY, WASH.														
1935	1.0131	1.0163	1.0146	1.0166	1.0193	1.0181	1.0203	1.0216	1.0216	1.0213	1.0200	1.0190	1.0185	1.0237 1.0040
1936	126	166	157	160	148	135	175	208	217	218	221	167	175	236 043
1937	189	167	158	153	166	173	201	204	213	201	150	157	178	272 056
1938	136	157	153	131	177	199	205	217	212	210	179	178	180	234 007
1939	150	136	154	174	183	182	183	219	213	216	208	190	184	233 060
Mean Density	1.0146	1.0158	1.0154	1.0157	1.0173	1.0174	1.0193	1.0213	1.0214	1.0212	1.0192	1.0176	1.0181	1.0272 1.0007
Salinity	20.1	21.7	21.2	21.6	23.7	23.8	26.3	28.9	29.0	28.8	26.1	24.0	24.7	36.6 2.0
RAYMOND, WILLAPA RIVER, WASH.														
1935	---	---	1.0010	1.0045	1.0051	1.0070	1.0097	1.0143	1.0142	1.0148	1.0123	1.0093	---	---
1936	1.0009	1.0079	024	059	051	040	068	---	---	---	105	064	---	---
1937	052	030	041	017	044	050	063	---	---	---	047	020	---	---
1938	024	035	036	026	053	101	129	158	166	144	043	049	1.0080	1.0179 1.0002
1939	036	027	030	069	098	071	097	154	163	149	115	056	089	184 004
1940	054	020	025	027	039	112	152	147	148	107	064	053	079	178 004
1941	054	072	085	088	080	084	124	152	084	095	064	039	085	178 005
1942	058	047	---	---	---	---	---	---	---	---	---	---	---	---
Mean Density	1.0041	1.0044	1.0035	1.0047	1.0059	1.0075	1.0104	1.0151	1.0141	1.0129	1.0080	1.0053	1.0073	1.0184 1.0002
Salinity	6.4	6.8	5.6	7.2	8.8	10.8	14.6	20.8	19.5	17.9	11.5	8.0	10.6	25.1 1.3



Density of Sea Water - *Continued*

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Means	Extremes Max. Min.
EVERETT, WASH.														
1934	---	---	---	---	---	---	---	1.0293	1.0189	1.0183	1.0146	1.0156	---	---
1935	1.0153	1.0131	1.0158	1.0139	1.0101	1.0104	1.0113	169	---	---	---	---	---	---
BREMERTON, WASH.														
1934	---	---	---	---	---	---	1.0217	1.0221	1.0222	1.0221	1.0218	1.0213	---	---
1935	1.0198	1.0198	1.0204	1.0208	1.0213	1.0215	216	219	222	222	222	215	1.0212	1.0236 1.0097
1936	217	216	---	---	---	209	219	218	---	223	224	---	---	---
SEATTLE (Elliott Bay), WASH.														
1922	1.0189	1.0186	1.0174	1.0146	1.0140	1.0171	1.0199	1.0208	1.0213	---	1.0211	1.0206	---	1.0224 1.0068
1923	172	193	188	168	177	180	201	208	213	1.0212	216	200	1.0194	223 117
1924	198	164	185	184	190	205	216	219	223	221	198	189	200	232 099
1925	193	181	190	175	182	195	206	210	214	218	218	212	200	225 110
1926	201	199	185	197	202	206	216	220	218	212	211	203	206	224 149
1927	198	183	177	176	160	164	205	211	210	204	194	189	189	220 101
1928	183	196	182	167	173	187	203	211	216	211	213	216	197	222 138
1929	215	211	203	194	183	176	205	215	218	220	220	214	207	228 111
1930	214	190	193	183	189	194	203	210	212	212	216	214	202	221 136
1931	201	200	191	175	176	190	198	207	210	207	203	206	197	220 137
1932	194	195	166	166	171	177	191	202	208	210	183	187	188	221 123
1933	183	199	184	179	179	171	187	201	203	196	190	168	187	217 131
1934	169	182	177	180	186	196	204	206	210	211	199	199	193	217 127
1935	188	185	185	188	182	190	200	207	210	212	214	215	198	220 145





Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Means	Extremes Max. Min.
ANACORTES, WASH.														
1922	1.0220	1.0220	1.0222	1.0224	1.0228	1.0221	1.0217	1.0223	1.0220	1.0224	1.0223	1.0226	1.0222	1.0240 1.0192
1923	220	222	223	225	224	224	222	225	221	224	226	224	223	233 194
1924	222	219	220	224	226	---	---	---	---	---	---	---	---	---
1934	---	---	---	---	---	---	---	---	---	---	222	219	---	---
1935	217	210	215	215	216	219	209	214	218	---	---	---	---	---
Mean Density	1.0220	1.0218	1.0220	1.0222	1.0224	1.0221	1.0216	1.0221	1.0220	1.0224	1.0224	1.0223	1.0221	1.0240 1.0192
Salinity	29.8	29.5	29.8	30.0	30.3	29.9	29.3	29.9	29.8	30.3	30.3	30.2	29.9	32.4 26.1
FRIDAY HARBOR, SAN JUAN I., WASH.														
1934	---	---	---	---	---	1.0223	1.0228	1.0228	1.0223	1.0228	1.0227	1.0224	---	---
1935	1.0222	1.0219	1.0221	1.0220	1.0222	222	216	218	225	228	228	229	1.0222	1.0232 1.0185
1936	228	232	227	229	226	223	219	220	222	227	229	231	226	234 195
1937	229	231	230	229	227	226	219	222	214	228	227	214	225	236 195
1938	212	215	224	223	223	221	218	225	228	229	229	228	223	231 176
1939	226	226	228	228	221	225	218	220	226	228	226	224	225	232 190
1940	219	221	220	222	218	218	220	222	235	228	226	226	222	229 194
1941	225	222	224	224	219	224	221	225	226	226	225	224	224	234 189
1942	222	222	224	226	226	---	---	---	---	---	---	---	---	---
1943	---	---	---	---	---	---	---	---	---	---	228	226	---	---
1944	226	225	227	228	228	228	227	227	228	225	226	224	227	247 200
1945	222	220	223	220	221	214	---	---	---	---	---	---	---	---
Mean Density	1.0223	1.0223	1.0225	1.0225	1.0223	1.0222	1.0221	1.0223	1.0224	1.0227	1.0227	1.0225	1.0224	1.0247 1.0176
Salinity	30.2	30.2	30.4	30.4	30.2	30.0	29.9	30.2	30.3	30.7	30.7	30.4	30.3	33.3 24.0

# KETCHIKAN, ALASKA

1922	---	---	1.0229	1.0226	1.0205	1.0190	1.0210	1.0201	1.0183	1.0182	1.0170	1.0202	---	---	1.0233	1.0080
1923	1.0222	1.0227	214	206	197	185	184	185	183	189	170	---	---	233	117	
1924	208	205	213	225	200	178	177	192	167	177	191	207	1.0195	238	119	
1925	230	231	229	221	200	181	177	183	192	212	197	173	202	239	131	
1926	170	197	190	204	201	194	197	192	209	198	201	213	197	228	128	
1927	220	227	224	224	216	197	182	191	197	182	206	222	207	242	160	
1928	202	208	208	208	189	175	178	185	208	195	197	204	196	229	115	
1929	203	227	220	224	218	199	181	177	198	187	170	193	200	236	101	
1930	221	224	222	221	212	180	185	188	204	183	173	165	198	237	102	
1931	177	197	209	216	197	190	188	183	189	188	187	214	195	254	139	
1932	214	225	211	216	203	196	180	177	173	176	181	209	197	233	128	
1933	214	228	224	217	203	182	171	162	173	179	171	192	193	230	132	
1934	202	189	205	208	196	188	183	190	193	191	186	203	194	227	129	
1935	225	206	212	215	216	219	223	222	221	212	210	207	216	230	168	
1936	210	207	212	215	212	203	190	212	192	165	111	122	188	231	101	
1937	199	202	193	202	192	204	166	121	138	175	170	162	178	226	107	
1938	189	195	202	191	207	197	194	196	201	180	198	200	196	223	106	
1939	200	216	227	218	195	186	179	170	175	177	173	173	191	267	112	
1940	207	217	216	208	213	211	196	171	187	198	193	187	201	231	149	
1941	211	215	226	218	214	214	206	205	204	---	174	186	---	238	139	
1942	---	216	213	225	215	209	205	208	199	183	179	202	---	233	152	
1943	204	218	221	225	224	224	217	201	---	188	184	192	---	242	124	
1944	187	202	223	224	224	225	204	178	186	186	189	197	202	244	132	
1945	219	230	234	233	222	194	193	198	198	193	198	216	211	246	167	
Mean Density	1.0206	1.0213	1.0216	1.0216	1.0207	1.0197	1.0190	1.0187	1.0190	1.0187	1.0182	1.0193	1.0198	1.0267	1.0080	

## Density of Sea Water - Continued

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Means	Extremes Max. Min.
SITKA, ALASKA														
1924	---	---	---	---	---	---	---	---	---	1.0177	1.0195	1.0192	---	---
1925	1.0211	1.0228	1.0213	1.0211	1.0159	1.0164	1.0136	1.0151	1.0157	172	179	179	1.0180	1.0233 1.0082
1943	---	---	---	---	190	177	174	172	166	189	211	200	---	---
1944	218	221	220	216	197	172	181	184	181	193	206	209	200	234 102
1945	220	221	211	212	177	166	165	181	178	185	221	222	196	235 109
Mean Density	1.0216	1.0223	1.0215	1.0213	1.0181	1.0170	1.0164	1.0172	1.0170	1.0183	1.0202	1.0200	1.0192	1.0235 1.0082
Salinity	29.3	30.2	29.1	28.9	24.7	23.3	22.5	23.5	23.3	25.0	27.4	27.2	26.1	31.8 11.8
JUNEAU, ALASKA														
1936	---	---	---	---	1.0134	1.0105	1.0099	1.0112	1.0132	1.0097	1.0132	---	---	---
1937	1.0207	1.0218	1.0218	1.0214	120	094	097	098	116	130	192	1.0206	1.0159	1.0246 1.0012
1938	212	213	211	206	150	124	099	104	120	133	182	192	162	237 032
1939	216	214	224	214	176	110	085	079	093	144	185	196	161	233 005
1940	211	219	224	214	150	129	088	105	---	---	---	---	---	---
1941	---	---	---	---	---	---	---	---	---	167	187	220	---	---
1942	192	211	---	208	141	101	090	098	115	132	199	218	---	229 040
1943	212	210	214	161	135	090	058	072	104	122	154	---	---	230 012
1944	199	205	208	168	128	082	081	095	111	108	158	181	144	228 032
1945	204	217	218	219	140	101	096	091	104	109	202	225	160	244 029
Mean Density	1.0207	1.0213	1.0217	1.0200	1.0142	1.0104	1.0088	1.0095	1.0112	1.0127	1.0177	1.0205	1.0157	1.0246 1.0005
Salinity	28.1	28.9	29.4	27.2	19.6	14.6	12.6	13.5	15.7	17.6	24.2	27.8	21.6	33.2 1.7

SKAGWAY, ALASKA

[illegible]

## SEWARD, ALASKA

1926	1.0181	1.0200	1.0180	1.0176	1.0128	1.0121	1.0037	1.0049	1.0120	1.0162	1.0141	1.0209	1.0142	1.0251	1.0001
1927	216	215	225	220	205	064	019	048	---	194	209	---	---	274	0.9998
1928	---	---	218	209	153	135	059	093	137	186	198	208	---	269	1.0005
1929	227	227	233	207	175	056	060	086	065	---	158	231	---	274	009
1930	250	---	175	216	168	109	064	051	133	204	214	210	---	294	005
1931	218	215	224	210	177	082	058	068	145	183	193	220	166	234	000
1932	228	236	222	212	196	139	095	091	158	146	218	218	180	251	006
1933	228	223	235	230	182	133	083	081	158	207	205	237	184	249	001
1934	228	204	211	189	115	087	097	072	108	142	187	187	152	266	0.9998
1935	215	205	223	216	179	097	052	127	138	166	206	217	170	264	1.0000
1936	208	214	223	210	173	084	092	069	145	129	156	193	158	233	0.9999
1937	214	225	218	222	166	080	073	119	108	131	091	037	140	237	1.0000
1938	037	043	050	055	175	085	060	090	100	137	190	182	100	265	001
1939	215	222	233	229	177	078	052	059	162	184	186	210	167	249	0.9996
1944	---	---	---	---	---	---	---	---	---	156	198	200	---	---	---
1945	197	204	215	212	149	061	066	042	127	128	210	207	152	231	1.0002
Mean															
Density	1.0204	1.0203	1.0206	1.0201	1.0168	1.0094	1.0064	1.0076	1.0129	1.0164	1.0185	1.0198	1.0158	1.0294	0.9996
Salinity	27.7	27.6	28.0	27.3	23.0	13.3	9.4	11.0	17.9	22.5	25.2	26.9	21.7	39.4	0.5

Density of Sea Water - *Continued*

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Means	Extremes Max. Min.
YAKUTAT, ALASKA														
1940	---	---	---	---	---	---	---	---	---	1.0204	1.0221	1.0226	---	---
1941	1.0228	1.0226	1.0219	1.0216	---	---	---	1.0172	1.0204	---	218	225	---	---
1942	220	216	218	218	1.0205	1.0189	1.0155	169	---	203	218	228	---	1.0265 1.0105
1943	221	227	---	217	213	201	192	---	188	200	208	201	---	236 174
1944	212	216	215	213	---	179	164	166	184	187	---	---	---	---
1945	224	224	221	224	204	201	190	177	182	200	222	225	1.0208	237 146
Mean Density	1.0221	1.0222	1.0218	1.0218	1.0207	1.0192	1.0175	1.0171	1.0190	1.0199	1.0217	1.0221	1.0205	1.0265 1.0105
Salinity	29.9	30.0	29.5	29.5	28.1	26.1	23.9	23.4	25.9	27.1	29.4	29.9	27.8	35.6 14.8
KODIAK, ALASKA														
1935	---	---	---	---	1.0225	1.0228	1.0232	1.0238	1.0226	1.0228	1.0231	1.0231	---	---
1936	1.0227	1.0232	1.0237	1.0241	221	229	---	---	---	---	---	---	---	---
SWEEPER COVE, ADAK ISLAND, ALASKA														
1943	---	---	---	---	---	---	---	---	---	---	1.0180	1.0218	---	---
1944	1.0238	1.0225	1.0210	1.0203	1.0223	1.0237	---	---	---	1.0183	182	185	---	1.0258 1.0066
1945	197	204	173	167	186	208	1.0228	1.0227	1.0214	---	---	188	---	251 077
CONSTANTINE HARBOR, AMCHITKA ISLAND, ALASKA														
1944	---	---	---	---	---	1.0248	1.0247	1.0243	1.0243	1.0243	1.0243	1.0243	---	---
1945	1.0245	---	---	---	---	---	244	245	238	241	242	240	---	---



## HONOLULU, T. H.

1944	---	1.0249	---	1.0248	1.0249	1.0249	1.0256	1.0257	1.0255	1.0256	1.0258	1.0254	---	---	---
1945	1.0255	258	1.0260	258	262	261	260	260	260	261	259	256	1.0259	1.0270	1.0226

## SAND ISLAND, MIDWAY ISLANDS

1944	---	1.0265	1.0262	1.0261	---	1.0262	1.0263	1.0260	1.0256	1.0257	1.0256	1.0256	---	1.0274	1.0246
1945	1.0258	256	259	265	1.0265	272	---	---	---	---	---	---	---	---	---

## PUNTA ARENAS, MAGELLAN STRAIT, CHILE

1944	---	---	---	1.0230	1.0226	1.0222	1.0225	1.0224	1.0227	1.0229	1.0229	1.0230	---	---	---
------	-----	-----	-----	--------	--------	--------	--------	--------	--------	--------	--------	--------	-----	-----	-----

## PUERTO MONTT, CHILE

1944	---	---	---	---	1.0238	1.0225	1.0228	1.0235	1.0232	1.0229	1.0199	---	---	---	---
------	-----	-----	-----	-----	--------	--------	--------	--------	--------	--------	--------	-----	-----	-----	-----

## VALPARAISO, CHILE

1944	---	---	1.0265	1.0261	1.0262	1.0260	1.0261	1.0256	1.0263	1.0262	1.0263	1.0259	---	1.0277	1.0240
1945	1.0263	1.0264	267	261	258	261	259	259	258	260	263	266	1.0262	291	249

Density of Sea Water - *Continued*

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Means	Extremes Max. Min.
MATARANI, PERU														
1944	---	---	1.0262	1.0262	1.0262	1.0260	1.0264	1.0263	1.0263	1.0264	1.0262	---	---	1.0280 1.0247
1945	1.0262	---	---	265	264	263	264	261	264	265	264	1.0264	---	276 249
CALLAO, PERU														
1944	---	1.0239	1.0234	1.0235	1.0242	1.0244	---	1.0247	1.0248	1.0250	1.0251	1.0254	---	1.0275 1.0214
1945	1.0257	253	248	245	252	245	1.0248	254	256	250	253	252	1.0252	269 227
TALARA, PERU														
1944	---	---	---	---	1.0268	1.0267	1.0261	1.0264	1.0268	1.0266	1.0266	1.0269	---	1.0279 1.0249
1945	1.0260	1.0259	1.0264	1.0270	272	271	273	---	---	---	---	267	---	275 256

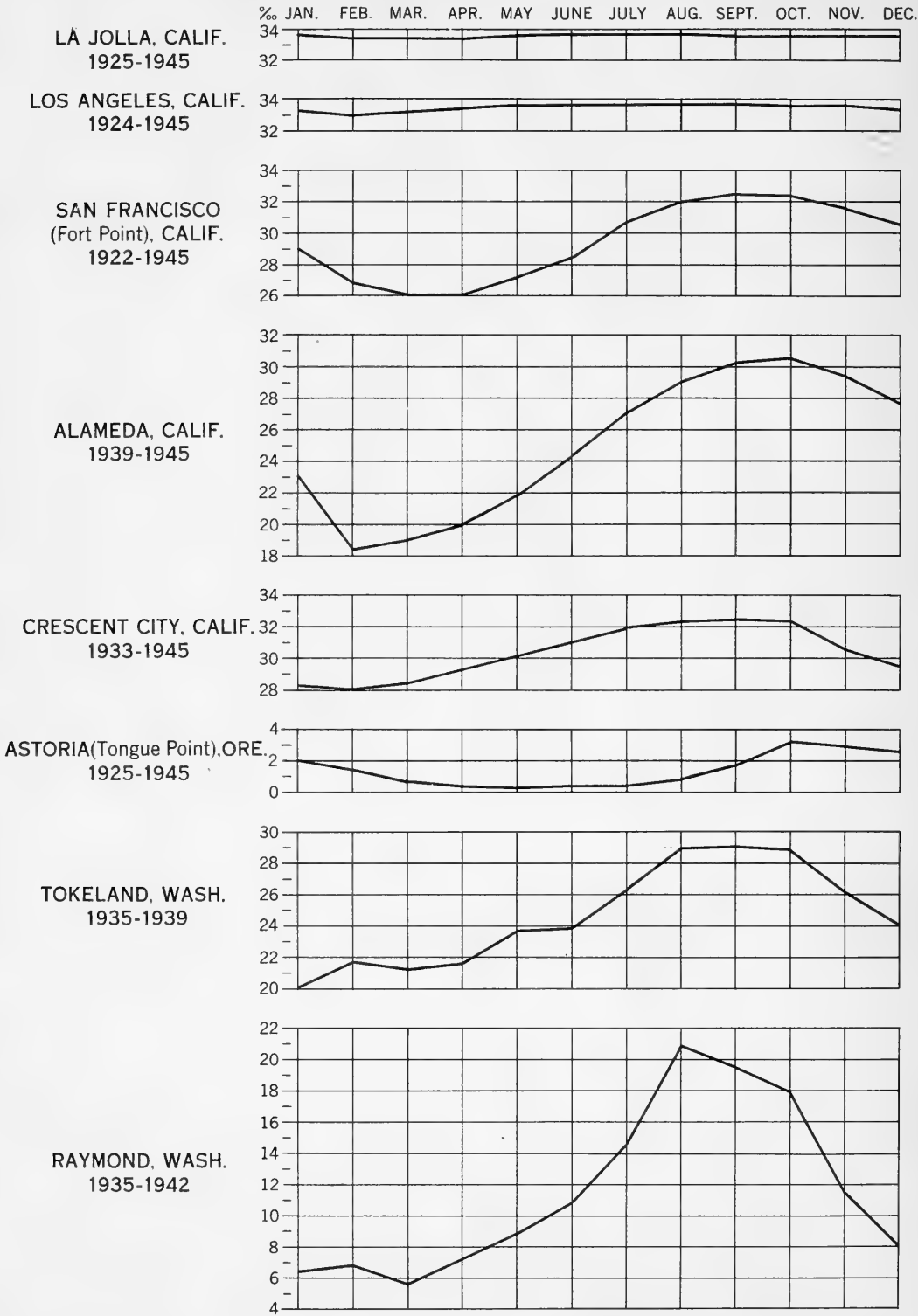
# Salinity of Sea Water

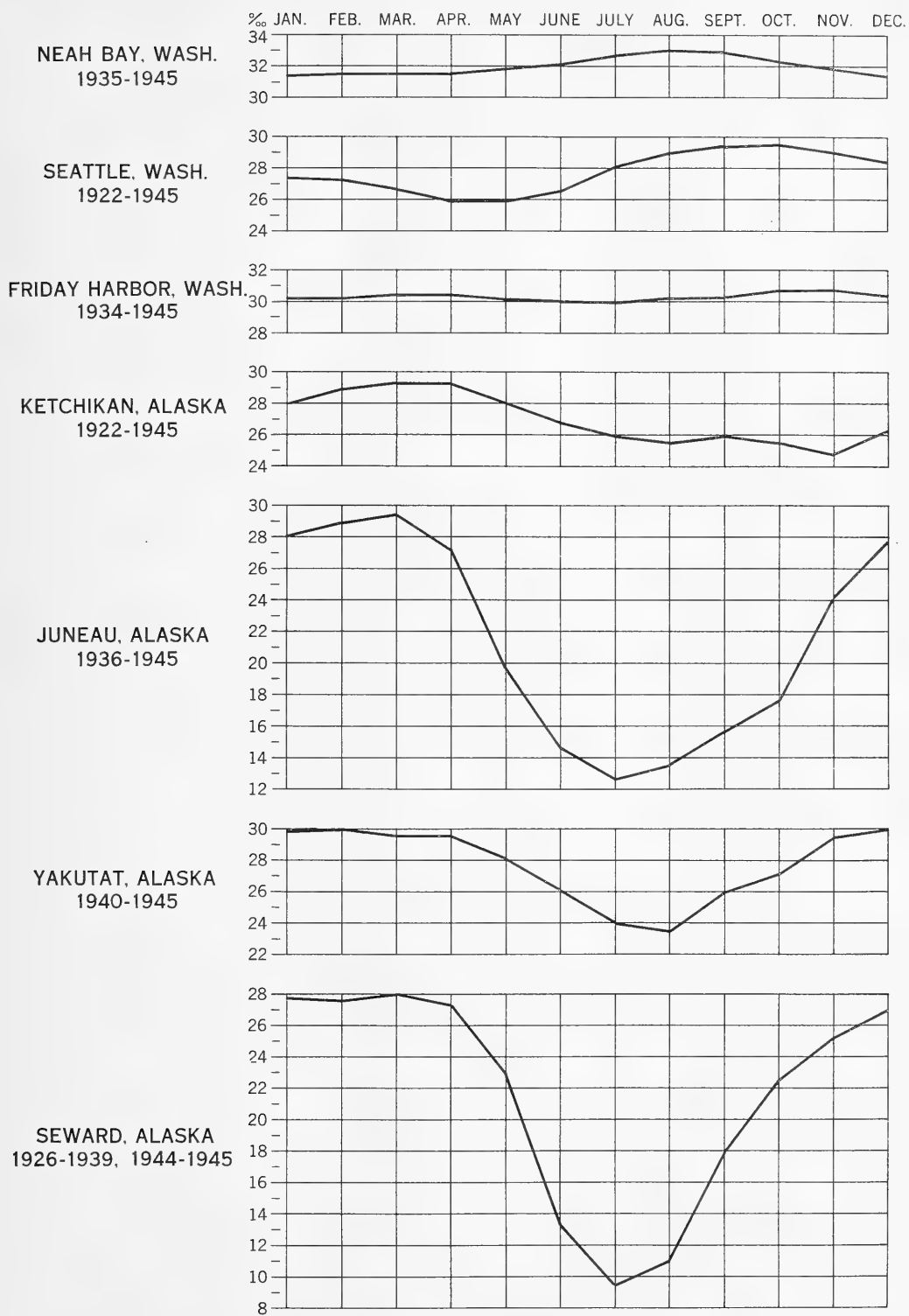
Average monthly surface salinities, in parts per thousand, furnished by the Scripps Institution, La Jolla, Calif.

Series	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Means
1925-1945	33.53	33.40	33.49	33.60	33.67	33.69	33.72	33.68	33.62	33.61	33.61	33.57	33.60
	BALBOA PIER, CALIF.												
1919-1945	33.45	33.39	33.30	33.61	33.60	33.62	33.64	33.58	33.56	33.58	33.59	33.51	33.54
	HUENEME PIER, CALIF.												
1919-1945	33.35	33.19	33.19	33.37	33.61	33.71	33.73	33.70	33.62	33.53	33.44	33.38	33.49
	PACIFIC GROVE, CALIF.												
1925-1942	33.12	32.94	33.02	33.20	33.45	33.68	33.76	33.76	33.66	33.62	33.49	33.40	33.43
	NORTH FARALLON ISLAND, CALIF.												
1922-1941	33.07	32.99	33.03	33.11	33.49	33.69	33.84	33.77	33.64	33.54	33.28	33.19	33.39
	BLUNTS REEF LIGHTSHIP												

Salinity of Sea Water  
Monthly means in parts per thousand

The seasonal variation of salinity is here shown graphically for those Coast and Geodetic Survey stations where observations cover five years or more.













# CORRESPONDING DENSITIES AND SALINITIES

[Density at 15° C.—Salinity in parts per 1,000]

Density	Salinity	Density	Salinity	Density	Salinity	Density	Salinity	Density	Salinity	Density	Salinity
0.9991	0.0	1.0046	7.1	1.0101	14.2	1.0156	21.4	1.0211	28.6	1.0266	35.8
.9992	.0	1.0047	7.2	1.0102	14.4	1.0157	21.6	1.0212	28.8	1.0267	35.9
.9993	.1	1.0048	7.3	1.0103	14.5	1.0158	21.7	1.0213	28.9	1.0268	36.0
.9994	.3	1.0049	7.5	1.0104	14.6	1.0159	21.8	1.0214	29.0	1.0269	36.2
.9995	.4	1.0050	7.6	1.0105	14.8	1.0160	22.0	1.0215	29.1	1.0270	36.3
.9996	.5	1.0051	7.7	1.0106	14.9	1.0161	22.1	1.0216	29.3	1.0271	36.4
.9997	.7	1.0052	7.9	1.0107	15.0	1.0162	22.2	1.0217	29.4	1.0272	36.6
.9998	.8	1.0053	8.0	1.0108	15.2	1.0163	22.4	1.0218	29.5	1.0273	36.7
.9999	.9	1.0054	8.1	1.0109	15.3	1.0164	22.5	1.0219	29.7	1.0274	36.8
1.0000	1.1	1.0055	8.2	1.0110	15.4	1.0165	22.6	1.0220	29.8	1.0275	37.0
1.0001	1.2	1.0056	8.4	1.0111	15.6	1.0166	22.7	1.0221	29.9	1.0276	37.1
1.0002	1.3	1.0057	8.5	1.0112	15.7	1.0167	22.9	1.0222	30.0	1.0277	37.2
1.0003	1.4	1.0058	8.6	1.0113	15.8	1.0168	23.0	1.0223	30.2	1.0278	37.3
1.0004	1.6	1.0059	8.8	1.0114	16.0	1.0169	23.1	1.0224	30.3	1.0279	37.5
1.0005	1.7	1.0060	8.9	1.0115	16.1	1.0170	23.3	1.0225	30.4	1.0280	37.6
1.0006	1.8	1.0061	9.0	1.0116	16.2	1.0171	23.4	1.0226	30.6	1.0281	37.7
1.0007	2.0	1.0062	9.2	1.0117	16.3	1.0172	23.5	1.0227	30.7	1.0282	37.9
1.0008	2.1	1.0063	9.3	1.0118	16.5	1.0173	23.7	1.0228	30.8	1.0283	38.0
1.0009	2.2	1.0064	9.4	1.0119	16.6	1.0174	23.8	1.0229	31.0	1.0284	38.1
1.0010	2.4	1.0065	9.6	1.0120	16.7	1.0175	23.9	1.0230	31.1	1.0285	38.2
1.0011	2.5	1.0066	9.7	1.0121	16.9	1.0176	24.0	1.0231	31.2	1.0286	38.4
1.0012	2.6	1.0067	9.8	1.0122	17.0	1.0177	24.2	1.0232	31.4	1.0287	38.5
1.0013	2.8	1.0068	9.9	1.0123	17.1	1.0178	24.3	1.0233	31.5	1.0288	38.6
1.0014	2.9	1.0069	10.1	1.0124	17.3	1.0179	24.4	1.0234	31.6	1.0289	38.8
1.0015	3.0	1.0070	10.2	1.0125	17.4	1.0180	24.6	1.0235	31.8	1.0290	38.9
1.0016	3.2	1.0071	10.3	1.0126	17.5	1.0181	24.7	1.0236	31.9	1.0291	39.0
1.0017	3.3	1.0072	10.5	1.0127	17.6	1.0182	24.8	1.0237	32.0	1.0292	39.2
1.0018	3.4	1.0073	10.6	1.0128	17.8	1.0183	25.0	1.0238	32.1	1.0293	39.3
1.0019	3.5	1.0074	10.7	1.0129	17.9	1.0184	25.1	1.0239	32.3	1.0294	39.4
1.0020	3.7	1.0075	10.8	1.0130	18.0	1.0185	25.2	1.0240	32.4	1.0295	39.6
1.0021	3.8	1.0076	11.0	1.0131	18.2	1.0186	25.4	1.0241	32.5	1.0296	39.7
1.0022	3.9	1.0077	11.1	1.0132	18.3	1.0187	25.5	1.0242	32.7	1.0297	39.8
1.0023	4.1	1.0078	11.2	1.0133	18.4	1.0188	25.6	1.0243	32.8	1.0298	39.9
1.0024	4.2	1.0079	11.4	1.0134	18.6	1.0189	25.8	1.0244	32.9	1.0299	40.1
1.0025	4.3	1.0080	11.5	1.0135	18.7	1.0190	25.9	1.0245	33.0	1.0300	40.2
1.0026	4.5	1.0081	11.6	1.0136	18.8	1.0191	26.0	1.0246	33.2	1.0301	40.3
1.0027	4.6	1.0082	11.8	1.0137	19.0	1.0192	26.1	1.0247	33.3	1.0302	40.4
1.0028	4.7	1.0083	11.9	1.0138	19.1	1.0193	26.3	1.0248	33.4	1.0303	40.6
1.0029	4.8	1.0084	12.0	1.0139	19.2	1.0194	26.4	1.0249	33.6	1.0304	40.7
1.0030	5.0	1.0085	12.2	1.0140	19.4	1.0195	26.5	1.0250	33.7	1.0305	40.8
1.0031	5.1	1.0086	12.3	1.0141	19.5	1.0196	26.7	1.0251	33.8	1.0306	41.0
1.0032	5.2	1.0087	12.4	1.0142	19.6	1.0197	26.8	1.0252	34.0	1.0307	41.1
1.0033	5.4	1.0088	12.6	1.0143	19.7	1.0198	26.9	1.0253	34.1	1.0308	41.2
1.0034	5.5	1.0089	12.7	1.0144	19.9	1.0199	27.1	1.0254	34.2	1.0309	41.4
1.0035	5.6	1.0090	12.8	1.0145	20.0	1.0200	27.2	1.0255	34.4	1.0310	41.5
1.0036	5.8	1.0091	12.9	1.0146	20.1	1.0201	27.3	1.0256	34.5	1.0311	41.6
1.0037	5.9	1.0092	13.1	1.0147	20.3	1.0202	27.4	1.0257	34.6	1.0312	41.8
1.0038	6.0	1.0093	13.2	1.0148	20.4	1.0203	27.6	1.0258	34.7	1.0313	41.9
1.0039	6.2	1.0094	13.3	1.0149	20.5	1.0204	27.7	1.0259	34.9	1.0314	42.0
1.0040	6.3	1.0095	13.5	1.0150	20.6	1.0205	27.8	1.0260	35.0	1.0315	42.1
1.0041	6.4	1.0096	13.6	1.0151	20.8	1.0206	28.0	1.0261	35.1	1.0316	42.3
1.0042	6.6	1.0097	13.7	1.0152	20.9	1.0207	28.1	1.0262	35.3	1.0317	42.4
1.0043	6.7	1.0098	13.9	1.0153	21.0	1.0208	28.2	1.0263	35.4	1.0318	42.5
1.0044	6.8	1.0099	14.0	1.0154	21.2	1.0209	28.4	1.0264	35.5	1.0319	42.7
1.0045	7.0	1.0100	14.1	1.0155	21.3	1.0210	28.5	1.0265	35.6	1.0320	42.8

